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RUBBER RESEARCH SCHEME (CEYLON)

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1. INTRODUCTION

THIS article is the second of a series of annual reviews on the general position of Rubber diseases and pests in Ceylon. The object of these articles, as stated in the first number [1], is to keep planters in touch with the general disease position, and to acquaint them briefly of any important developments during the year under review.

2. ROOT AND COLLAR DISEASES

As regards fungus diseases there are no new developments to report for 1930. The low price of rubber has unfortunately necessitated the curtailment of control measures against the two most important fungi, *Fomes lignosus* and *Ustulina zonata*, and it is feared that considerable loss on account of these diseases may consequently be experienced in certain districts during the next few years. Every possible care to prevent the spread of root disease and *Ustulina* collar and stem rot should be taken, so that the necessity for the expenditure of large sums of money in the future may be avoided.

Termites.—A number of instances of attack on Rubber trees by termites ("white-ants") have been reported in Ceylon during the year. In Malaya and the Dutch East Indies *Coptotermes gestroi* has for some years been notorious as a root parasite of *Hevea*. This species, however, is not known in Ceylon, and until recently it was believed that none of the Ceylon termites were able to attack healthy Rubber trees. Unfortunately this view can no longer be entertained, and in the light of recent observations it is possible that the concern with which these pests have been regarded by the Tea planter for many years may, in future, be shared by the Rubber planter also.

An account of termite attack on *Hevea* in Ceylon is given by Jepson [2] in Rubber Research Scheme Quarterly Circular Vol. 7, Part 3. Broadly speaking there are two types of termite attack on *Hevea*:

(1) The termite can only gain entrance through dead or diseased wood such as is provided by *Ustulina* attack or a broken branch. Having thus gained entrance, however, it can attack and destroy healthy wood and may penetrate to the roots, thus causing the ultimate death of the tree. Certain species of *Calotermes* have been found attacking *Hevea* stems in this way. Such attacks can be guarded against by the removal of dead and diseased branches.

(2) The termite can gain entrance underground through a healthy root, and, working upwards, may hollow out the trunk and kill the tree. One species, *Coptotermes ceylonicus*, has been found attacking *Hevea* in this way, though it has usually been associated with a root disease fungus. This is the most dangerous form of attack and no effective preventive measures can be taken.

In view of the lack of precise knowledge regarding the habits of some of the genera and the circumstances under which they may attack *Hevea*, further records and specimens will be welcomed.

3. STEM DISEASES

On those estates which stopped tapping during May, the incidence of Bark Rot when the cuts were re-opened in June was not so severe as had been anticipated. Although this was largely due to the comparative failure of the S. W. monsoon there is no doubt that this disease can be almost entirely prevented if careful control measures are adopted.

Canker is not considered to be of much importance except where the actual tapping surfaces are effected. At the present time, when the expenditure on disease treatment must, in common with all other items, be reduced to a minimum, it would be advisable on most estates to transfer the money usually spent on canker scraping to the control of root disease and *Ustulina*.

4. LEAF DISEASES

Secondary leaf-fall due to *Phytophthora palmivora* (*P. Faberi*) was not serious in 1930. It is possible, however, that the effects of this disease may become more marked while the low price of rubber necessitates the curtailment of regular manuring and cultivation.

Oidium.—In the main low-country districts the intensity of *Oidium* attack has not increased to any serious extent since the disease was first reported in 1925. Although the disease is now widespread it would appear that the conditions in the low-country are not favourable to prolonged spells of severe infection. At mid-country elevations, on the other hand, the fungus continues to cause extensive and serious defoliation on many estates, and

there is evidence of considerable decreases in yield due to the disease. A fair measure of control has been secured by means of sulphur dusting, and it is confidently expected that further experiments will achieve better results.

It is of interest to note that Beeley, [3] in Malaya, has found that the fungus sporulates more actively in a cold chamber (55°F) than at a normal tropical temperature. There can be no doubt that this fact provides the main explanation for the greater intensity of the disease at higher elevations in Ceylon.

A leaf scorch due to the application of calcium cyanamide in dry weather was much in evidence during the year. The margin of the leaf blade dies back and becomes whitish in colour, and the appearance is similar to that of a rim-blight of fungus origin. In severe cases the leaflets may fall. It is generally supposed that the burning is due to the formation of dicyanodiamide, a toxic compound which is liable to be formed in the absence of sufficient moisture. This manure is of great benefit when applied under suitable conditions, but it should not be applied in dry weather, particularly to soils deficient in humus.

5. DISEASES AND PESTS IN NURSERIES

The establishment of budwood nurseries for the multiplication of high-yielding clones has been undertaken by most companies, and nearly every estate in the main Rubber-growing districts now possesses a certain number of stumps budded from proved foreign clones. The possession of such valuable planting material has focussed attention on the various ailments to which young shoots are prone.

The most serious fungus disease of young Rubber buddings is a die-back of the green shoot caused by *Phytophthora palmivora*, the symptoms of which have been described by Murray [4]. Its incidence is markedly dependent on wet weather, and under favourable conditions a young shoot may be killed back in a few days. It is necessary, therefore, to keep a careful watch on nursery plants and to cut back any diseased shoots well below the margin of the discolouration. Successful control has been secured on many estates by periodically spraying with Bordeaux Mixture.

An attack on young bud shoots by *Rhizoctonia solani* was reported by Park [5] from an estate in the Kalutara district. This fungus is a common cause of disease on *Vigna* (*Dolichos Hosei*), but has not previously been reported on *Hevea*.

Various pests attack young shoots and check their growth. Mites cause distortion of young leaves chiefly in dry weather, and are most effectively controlled by dusting with sulphur powder. Slugs are often found to eat off the terminal shoot. By day it is

usually possible to find the slugs under stones, etc., and flat boards may be put down to trap them. They may be to some extent discouraged by periodically dusting with smokehouse ashes, and by putting a barrier ring of ashes on the ground round each plant.

It is a sound practice to spray all young shoots of valuable bud-grafted material with Bordeaux Mixture every week or ten days during wet weather, and to dust them periodically with sulphur powder during dry weather.

[For further particulars regarding diseases and pests in nurseries reference may be made to Rubber Research Scheme Quarterly Circular Vol. 7, Part 3, 1930, (6)].

COVER CROPS

The impression has been gained that the Kalutara snail (*Achatina fulica*) is not now causing so much damage to *Vigna* as formerly. The dying back of many areas of this cover is probably to be attributed to staling effects.

There has been no extensive fungus damage to cover crops.

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THE EFFECT OF BLANKETING ON THE PLASTICITY OF CREPE

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IN Bulletin 49, p. 7, attention was drawn to a statement by Mr. O'Brien that "the procedure adopted in blanketing crepe varies considerably. For example in certain factories water-cooled rolls are used so that the temperature of the rubber is kept low. On other estates uncooled rolls are used, but are allowed to cool down after half-an-hour's work. Again on other estates there is no interval for cooling and the rubber temperature may rise to 50-55°C. The number of rollings may vary from three to five."

A set of samples was therefore prepared to determine the effect of different practices during blanketing on the plasticity of crepe, and it was concluded from the results of tests that rolling for blanketing purposes might cause a considerable increase in plasticity particularly if the rolls were not water-cooled. Some of the results were irregular and required confirmation.

A further set of samples has now been prepared to study the effect on plasticity of conditions of rolling during blanketing. The samples consist of lace crepe (control), crepe passed three and six times respectively through water-cooled blanketing rolls, and crepe passed three and six times respectively through somewhat hotter air-cooled blanketing rolls.

The following are the results of plasticity tests:

Sample No.	Treatment during blanketing	Before storage	After storage for six months at 32°F		After storage for six months at 60°F	
		D_{30} mms./ 100	D_{30} mms./ 100	Mastic-ation No.	D_{30} mms./ 100	Mastic-ation No.
1496	Lace crepe (control)	171	155	92	165	93
1494	3 rollings water-cooled rolls. Temperature of rubber 41°C	155	170	100	168	99
1497	6 rollings water-cooled rolls	160	153	97	162	97
1498	3 rollings air-cooled rolls	156	155	95	162	100
1499	6 rollings air-cooled rolls. Temperature of rubber 58°C	156	145	87	151	84

The samples were tested soon after arrival in London and the control lace crepe was found to be distinctly harder than the blanket crepe samples. On storing for six months at 60°F, however, the control sample became softer and did not differ greatly from the others.

The sample which was blanketed under extreme conditions by rolling six times on comparatively hot rolls became much softer than the others on storage and required less mastication. The other samples did not show marked differences.

It is concluded that blanketing has little effect on plasticity when the temperature of the rolls is kept low but that it may have a marked effect if the rolls become hot. On the whole this agrees with the results of previous tests (Bulletin 49, p. 7). To obtain rubber of uniform plasticity it is desirable that the blanketing rolls should be water cooled.

THE CAUSE OF VARIABILITY IN THE PLASTICITY OF PLANTATION RUBBER AFTER STORAGE

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THERE are two reasons why a study of the plasticity of rubber is of importance to the planter, viz: (1) the variable plasticity of plantation rubber leads to many difficulties in manufacturing operations; and (2) first-grade plantation rubber is so hard that it is frequently mixed with inferior grades and other materials to enable it to pass more easily through the different processes.

The results of the investigations recorded in this report suggest a definite reason for the hardness and variability of first-grade rubber.

Tests carried out by De Vries in Java showed (1) the freshly prepared plantation rubber is uniform in plasticity but that many samples gradually become hard or soft on keeping and so develop differences; and (2) that rubber containing more serum substances than usual becomes hard and that containing less than usual becomes soft (Trans. I. R. I., **3**, 1927-28, p. 284). On the other hand tests carried out by the Scheme on a large number of samples of over three years show that in most cases rubber becomes harder on keeping for six months at 15°C. The hardening of the rubber at European temperatures has been confirmed by Griffiths of the Dunlop Rubber Co., Ltd., who stated that large-scale experiments on rubber from different estates showed that in all cases, after storage for three years, it was necessary to increase the time of milling by about 30 per cent in order to obtain the required plasticity (Trans. I. R. I., **3**, 1927-28, p. 300).

As raw rubber is subjected to a wide range of temperatures and humidity conditions before use by the manufacturer a detailed investigation is being carried out at the Imperial Institute on the effect of different conditions of storage.

The results of preliminary tests (Second Quarterly Circular of the Rubber Research Scheme, Ceylon, 1930) showed that (1) rubber becomes slightly harder at 15°C than at 0°C; and (2) rubber hardens more quickly in a dry than in a damp atmosphere.

Further experiments have now been made with crepe and sheet stored for six months at 0°C, 15°C, 30°C, and 45°C. As it was desirable to ascertain whether the changes in plasticity were due to changes in the rubber independent of external factors such as oxygen, some of the samples were kept in sealed glass tubes containing dry nitrogen and others in tubes containing dry oxygen. If oxygen is responsible for changes in the plasticity of rubber on storage, it might be anticipated that the changes would be accelerated by the removal of anti-oxidants from the rubber. Accordingly a portion of the sheet was treated with dilute ammonia solution for three weeks to remove anti-oxidants; another portion was treated with water for comparison; and a third with tannic acid solution, the tannic acid being regarded as a possible anti-oxidant. The results of the usual hardness tests at 100°C are shown in the following table and diagrammatically in Fig. 1.

Sample	* D_{30} (mm./100) before storage	* D_{30} (mm./100) after storage for six months in							
		Dry nitrogen at				Dry oxygen at			
		0°C	15°C	30°C	45°C	0°C	15°C	30°C	45°C
Crepe (No. 1452)	170	178	205	213	222	156	173	185	164
Smoked sheet (No. 1455)	191	186	203	208	215	173	183	182	182
Smoked sheet extracted with cold water	189	—	209	—	—	175	188	—	142
Smoked sheet extracted with ammonia	189	—	213	—	—	166	186	—	111
Smoked sheet soaked in tannic acid	189	—	217	—	—	170	191	—	162

* D_{30} = Thickness (in hundredths of a millimetre) of sphere 0·4 grams in weight after pressing under a load of 5 kgs. at 100°C for 30 minutes.

The results show that the changes in hardness which occur when rubber is stored in dry oxygen are different from those which occur on storage under the same conditions in nitrogen. In nitrogen the rubber becomes hard and the hardness increases with the temperature. In oxygen the rubber is always softer than in nitrogen at the same temperature and the difference increases with the temperature.

HARDNESS (D_{30}) of raw rubber after exposure for six months in dry OXYGEN or NITROGEN at different temperatures.

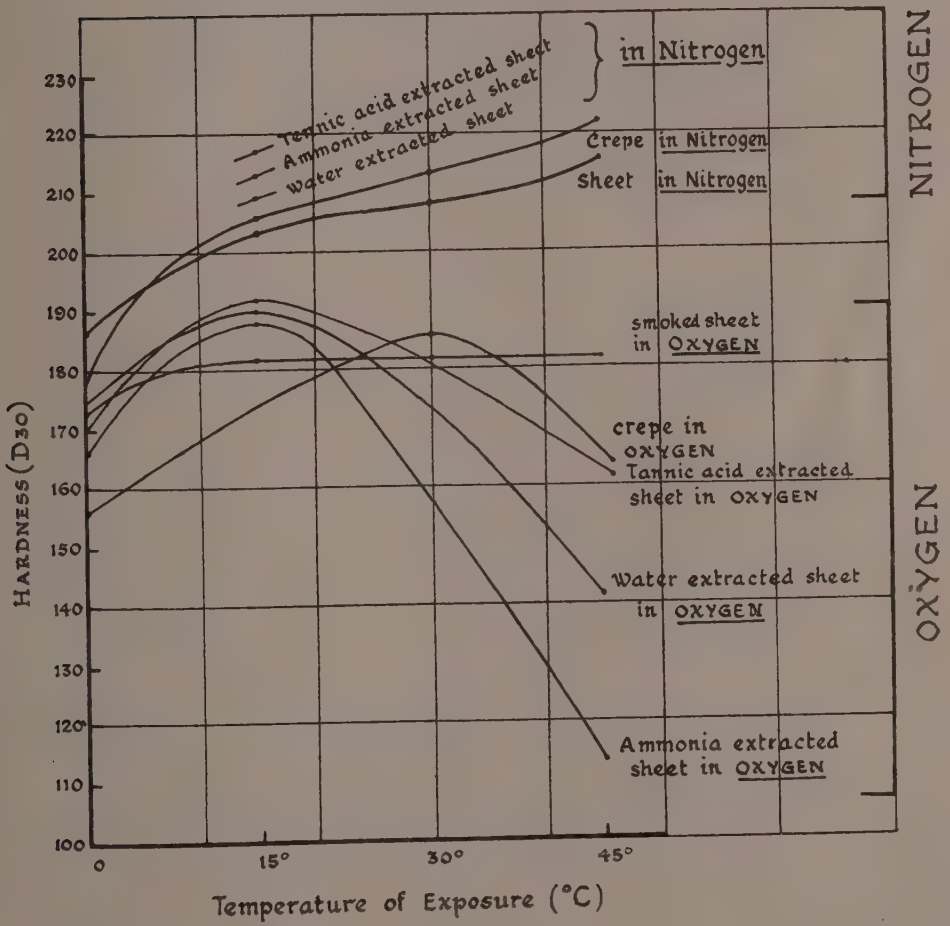

Fig. I.

These results suggest that two fundamental factors are responsible for the changes which occur in the plasticity of rubber on storage: (1) a spontaneous hardening which occurs in nitrogen and therefore probably in any inert atmosphere; and (2) a softening induced by oxygen. These changes occur simultaneously when oxygen is present, but an increase in temperature accelerates the rate of softening more than the rate of hardening. At low temperatures hardening exceeds softening and at high temperatures softening exceeds hardening and, as will be seen from the diagram, the critical temperature is about 30°C but depends upon accessory substances in the rubber.

The ammonia-extracted rubber became extremely soft in oxygen at 45°C, although it hardened at 15°C, whilst the same rubber not treated with ammonia had a tendency to harden even at 45°C. Previous experiments with ammonia-extracted rubber have indicated that it possesses poor ageing properties when vulcanised, and it is assumed that this is due to the removal of anti-oxidants. (Trans. I. R. I., 1926-7, **2**, p. 368). The removal of these constituents therefore appears to affect not only the ageing properties of the vulcanised material but also those of the raw material.

The water-extracted rubber also softened in oxygen at 45°C but not as much as the ammonia-extracted rubber; this also agrees with the results of the ageing tests on the vulcanised material referred to above. Tannic acid does not appear to have a marked anti-oxidant effect.

These results explain the differences previously observed between the effect of storage in the tropics and in Europe. At European temperatures spontaneous hardening nearly always exceeds softening due to oxygen, even when the amount of anti-oxidants, present is much less than usual. At tropical temperatures rubber becomes hard or soft according to the amount of serum substances present. These contain natural anti-oxidants, with the result that even at tropical temperatures rubber containing more serum than usual becomes hard.

Although this work is only in its initial stage the results indicate methods by which it may be possible to control the plasticity of rubber on estates.

THE EFFECT OF MATURATION ON THE PLASTICITY OF SMOKED SHEET

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IT is the practice in Java when preparing smoked sheet rubber to remove the coagulum from the serum on the same day as the acid is added, but in Malaya and Ceylon it is more useful to remove the coagulum on the day following. During the period the coagulum remains in the serum, changes occur in the non-rubber accessory substances which affect the rate of vulcanisation of the rubber. It is to be expected therefore that these changes occur to a greater extent in Ceylon and Malaya than in Java, and that the different practices lead to some variability in the properties of rubber.

Although the effect of keeping the coagulum in the serum has been studied thoroughly as regards rate of vulcanisation little is known as to whether the changes which occur affect the plasticity of rubber. This also is an important property affecting the utilisation of rubber.

Two sets of experiments were described in Bulletin 49, p. 2, showing that crepe from coagulum kept in the serum for two days was harder than crepe from coagulum removed after a few hours.

Two further sets of experiments have now been carried out in which the coagulum after keeping for different periods in the serum was rolled to sheet and smoked. The results obtainted are not in agreement with those given by crepe, the period the coagulum remained in the serum apparently having no effect on the plasticity of sheet. Mr. O'Brien (who prepared the samples) has suggested that the difference in the results given by crepe and sheet is due to the addition of sodium bisulphite to the latex when preparing crepe. This is a probable explanation because it has already been shown that sodium bisulphite has a hardening effect on rubber, and it is possible that the longer the coagulum remains in the serum the greater is the effect of the bisulphite.

More information concerning the different results given by crepe and sheet could be obtained by determining the plasticity of crepe prepared from latex containing no bisulphite and matured for different periods, and it is hoped to carry out this experiment when opportunity occurs.

The two sets of sheet samples were prepared at an interval of 18 months. A description of the first set and the results obtained are given in the Rubber Research Scheme, Quarterly Circular, Vol. 6, Part 2, 1929, p.1. The samples in each set were prepared from latex divided into two portions, one being coagulated with acetic acid and the other with a mixture of acetic acid and paranitrophenol. The latter is a disinfectant used chiefly for the prevention of mould. It was employed in these experiments to determine whether it retarded changes in the accessory substances during the period the coagulum was kept in the serum. In the second set a portion of the sheet from the coagulum which had been allowed to remain in the serum for the longest period was rolled up wet and kept in this condition for five days before drying in smoke. At the end of this period the sheets without paranitrophenol had a putrid odour but the others were still fresh.

Plasticity Tests.—The results of plasticity tests are shown in table I. They include a hardness test soon after the arrival of the samples in London and after keeping for six months, and in addition a mastication test on the stored samples.

The results show that keeping the coagulum in the serum had no definite effect on the hardness of the sheet samples on arrival in London or after storage for six months under different conditions (for detailed particulars of conditions of storage of the first set and the results obtained see Quarterly Circular, Vol. 6, 1929, Part 2, p. 2 and, Vol. 7, 1930, Part 2, p. 23). It is of interest however that the sample rolled up wet and free from paranitrophenol in the second set was harder than the others on arrival and required more mastication than the others after keeping at 60°F for six months. It is possible therefore that maturing the coagulum may cause a small decrease in plasticity, but this is not obvious from tests in which the coagulum is allowed to remain in the serum and then rolled and dried, because the biological changes may be accompanied by an alteration in the distribution of the non-rubber substances between the coagulum and the serum.

Paranitrophenol had no definite effect on the hardness of the samples except when these were stored in a damp atmosphere when the samples without paranitrophenol became mouldy and hard.

Vulcanisation Tests.—Most of the samples were submitted to tests to determine the extent to which the changes occurring during the maturing of the coagulum affected the rate of vulcanisation, and the influence of paranitrophenol on these changes. The results obtained are shown in table II. In the first set of experiments only small changes occurred in the rate of vulcanisation of the samples in consequence of keeping the coagulum in the serum and these changes were unaffected by paranitrophenol. In the second set of experiments the alterations were more marked. Keeping the coagulum in the serum for 44 hours as compared with 4 hours reduced the time of vulcanisation by 15 per cent in the absence of paranitrophenol and by 8 per cent in the presence of paranitrophenol. When the coagulum kept in the serum 44 hours was rolled up wet, the time of vulcanisation was reduced by a further 10 per cent in the absence of paranitrophenol and by 5 per cent in its presence.

In the first set of experiments paranitrophenol had little effect on the changes which occurred when coagulum was allowed to mature but in the second set it definitely retarded these changes. As the changes which occur during maturing may be partly due to accidental infection it is not surprising that different experiments do not always agree. It is evident that paranitrophenol may reduce variability due to differences arising during maturation of the coagulum but insufficient evidence has yet been obtained as to its general effect in this direction.

Set 1

Table I

Sample No.	Coagulant	Interval between addition of coagulant and rolling	On arrival in London	After storage for six months at 60°F	
			D_{30}	D_{30}	Mastication
		hrs.	mms./100	mms./100	No.
1,385	Acetic acid	4½	154	161	94
6	,, ,,	17¾	158	158	95
7	,, ,,	35½	156	165	95
8	,, ,,	40¼	156	161	120
9	,, ,,	55½	159	167	109
90	Acetic acid and	4½	151	156	104
1	paranitrophenol	17¾	158	151	109
2	,, ,,	35½	155	158	108
3	,, ,,	40¼	156	163	105
4	,, ,,	55½	155	167	107

Set 2

Sample No.	Coagulant	Interval between addition of coagulant and rolling	On arrival in London	After storage for six months at			
				32°F		60°F	
			D_{30}	D_{30}	Mastication	D_{30}	Mastication
			mms./100	mms./100	No.	mms./100	No.
1,500	Acetic acid	4	159	153	92	157	98
1,501	,, ,,	18	159	150	94	159	107
1,502	,, ,,	23	164	154	93	161	107
1,503	,, ,,	28	159	158	101	157	96
1,504	,, ,,	44	160	161	97	153	98
1,505	Acetic acid and	4	152	152	93	158	92
1,506	paranitrophenol	18	158	155	94	160	101
1,507	,, ,,	23	156	151	93	159	96
1,508	,, ,,	28	161	156	101	168	98
1,509	,, ,,	44	159	149	92	165	100
1,510	Acetic acid (sheeted coagulum rolled up wet)	44	169	156	96	170	110
1,511	Acetic acid and paranitrophenol (sheeted coagulum rolled up wet)	44	164	152	95	159	102
1,512	Estate sample	—	154	157	94	159	96

Table II

Set 1 — Mixing 90 rubber, 10 sulphur

Sample No.	Coagulant	Interval between addition of coagulant and rolling	Time of vulcanisation	Tensile Strength	Elongation at load of 1·04 kgs./sq. mm.	Calculated time of vulcanisation at 148°C (E 1·04 = 775)
			mins.	lb./sq. in.	per cent	
1,385	Acetic acid	4½	120	1,580	853	120
6	,, ,,	17¾	,,	1,670	848	118
7	,, ,,	35½	,,	1,850	832	114
8	,, ,,	40¼	,,	1,840	840	116
9	,, ,,	55½	,,	1,850	820	111
90	Acetic acid and paranitrophenol	4½	,,	1,460	860	121
1	,, ,,	17¾	,,	1,950	840	116
2	,, ,,	35½	,,	1,560	847	118
3	,, ,,	40¼	,,	1,830	824	112
4	,, ,,	55½	,,	1,950	824	112

Set 2 — Mixing 100 rubber, 10 sulphur

Sample No.	Coagulant	Interval between addition of coagulant and rolling	Time of vulcanisation	Tensile Strength	Elongation at load of 1·00 kgs./sq. mm.	Calculated time of vulcanisation at 148°C (E1·00 = 800)
			mins.	lb./sq. in.	per cent	
1,500	Acetic acid	4	120	1,970	846	134
			140	1,990	777	
1,504	,, ,,	14	100	1,710	852	114
			120	2,050	780	
1,505	Acetic acid and paranitrophenol	4	120	1,960	840	133
			140	2,120	776	
1,509	,, ,,	44	120	2,100	807	122
1,510	Acetic acid (sheeted coagulum rolled up wet)		100	2,230	807	102
1,510	Acetic acid and paranitrophenol (sheeted coagulum rolled up wet)	44	120	2,320	784	116

NOTICES.

SUBSCRIPTIONS.

Arrangements have now been made for Bulletins and Circulars of the Ceylon Rubber Research Scheme to be made available to non-contributors to the Scheme at the rate of Rs. 15-00 per annum, post free.

GLASS HYDROMETERS.

Glass hydrometers for testing latex and for testing formic acid as specified and as recommended by the Rubber Research Scheme (Ceylon) may be obtained at a cost of Rs. 12·50 and Rs. 10·50 each respectively, from :—

Messrs. WALKER, SONS & Co., Ltd.,
Engineering & Estate Supplies Department,
Colombo.